REMARKS

The undersigned acknowledges Examiner Nguyen granting a telephone conference with the undersigned regarding the referenced application. The undersigned explained the invention, the claim language that defines the invention and how the claimed invention can be distinguished from the cited prior art. The points of the discussion are incorporated in the following remarks.

Disposition of Claims
Claims 1-20 are pending.
Claims 1-20 are rejected.

The independent claims (as examined) are
1. A system for critical parameter analysis (CPA) of a semiconductor device (DUT) ...
11. A method for critical parameter analysis of a semiconductor device ...
20. A system for critical parameter analysis (CPA) of a semiconductor device (DUT) ...

Rejections under 35 USC 102 and 103

Claims 1-3,6-13, 16-19 are rejected under 35 U.S.C. 102(b) as being anticipated by Lo (US 6,462,814).

As to claims 1, 11, Lo disclosed (figs 1-3) a system and a method for critical parameter analysis (CPA) of a semiconductor device (DUT 12), comprising:

a focused optical beam scanning device (16, fig 3) for scanning and imaging the semiconductor device (DUT, 12) and for imparting light energy to illuminated portions of the semiconductor device (DUT, 12) during scanning,

automated test apparatus (ATE, 62, fig 1) for providing predefined stimulus to the semiconductor device (DUT, 12) and for comparing responses from the semiconductor device (DUT, 12) against a set of predefined expected responses,

and

a signal generator (test vectors, column 4 lines 46- 47) for providing an output signal indication when the automated test apparatus (ATE, 62) detects a difference between the responses from the semiconductor device (DUT) and the predefined expected responses,

wherein said focused optical beam scanning device and said ATE are adapted such that both operate upon the semiconductor device simultaneously.

As to claims 2, 12 Lo disclosed (figs 1-3) a system wherein semiconductor device (DUT, 12) is fixtured such that ATE (62) connections to the device (12) are made within a scanning chamber of the focused optical beam scanning device .

As to claims 3, 13, Lo disclosed (figs 1-3) a system wherein focused optical beam scanning device (13) is a laser scanning microscope (LSM).

As to claims 6 -8, 16 - 18, Lo disclosed (figs 1 - 3) a system wherein predefined stimulus is provided to automated test apparatus (ATE 62) in the form of a set of test vectors (column 4 lines 45- 47).

As to claim 9, Lo disclosed (figs 1-3) a system wherein output signal indication is a short pulse generated when a difference is detected between responses by semiconductor device (DUT) to predefined stimulus and the predefined expected responses.

As to claims 10, 19, Lo disclosed (figs 1-3) a system wherein ATE (62) is configured to repeatedly cycle said predefined stimulus from a starting point up a point of failure when such failure is detected.

Claims 4, 5, 14, 15, 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over by Lo (US 6,462,814) in view of Lo et al (US 6,566,897).

As to claims 4, 5, 14, 15, 20, Lo disclosed (figs 1-3) a system for critical parameter analysis (CPA) of a semiconductor device (OUT, 12), comprising:

a focused optical beam scanning device (16, fig 3) for scanning and imaging the semiconductor device (OUT, 12) and for imparting light energy to illuminated portions of the semiconductor device (OUT, 12) during scanning,

automated test apparatus (ATE, 62, fig 1) for providing predefined stimulus to the semiconductor device (DUT, 12) and for comparing responses from the semiconductor device (DUT, 12) against a set of predefined expected responses,

and

a signal generator (test vectors, column 4 lines 46- 47) for providing an output signal indication when the automated test apparatus (ATE, 62) detects a difference between the responses from the semiconductor device (DUT) and the predefined expected responses, wherein said focused optical beam scanning device and said ATE are adapted such that both operate upon the semiconductor device simultaneously,

However Lo is silent on the image converting means.

On the other hand, Lo et al teach image converting means for representing output from said focused optical beam scanning device (12) as a viewable video signal (84, 62) and for overlaying the output signal indication from the ATE on said viewable video signal, and display (62) means for viewing said video signal with overlaid ATE output signal indication.

It would have been obvious to one having an ordinary skill in the art at the time of the invention was made to add the viewable video signal for the purpose to observing the defected image.

The Invention, Generally

The present invention relates to semiconductor device testing, and more particularly to detecting failures and failure mechanisms in semiconductor integrated circuitry, especially CMOS (Complementary Metal-Oxide-Semiconductor) integrated circuitry.

A technique is described for performing critical parameter analysis (CPA) of a semiconductor device (DUT) by combining the capabilities of conventional automated test equipment (ATE) with a focused optical beam scanning device such as a laser scanning microscope (LSM). The DUT is provided with a fixture such that it can be simultaneously scanned by the LSM (or similar device) and exercised by the ATE. The ATE is used to determine pass/fail boundaries of operation of the DUT. Repeatable pass/fail limits (for timing, levels, etc...) are determined utilizing standard test patterns and methodologies. The ATE vector pattern(s) can then be programmed to 'loop' the test under a known passing or failing state. When light energy from the LSM scanning beam sufficiently disturbs the DUT to produce a transition (i.e., to push the

device outside of its critical parameter limits), this transition is indicated on the displayed image of the DUT – indicating to the user which elements of the DUT were implicated in the transition. While the ATE is exercising and monitoring the DUT, the LSM's scanning beam is traversing the DUT, applying light energy to the DUT wherever it scans. This light energy "disturbs" circuitry of the DUT wherever it strikes. Whenever a "disturbance" is significant enough to produce a change in the responses from the DUT that causes a mismatch between the DUT's responses and the predefined expected responses, the ATE flags a "transition" condition by generating its output signal indication. The output signal indication is then merged with an image (on a suitable display device) of the DUT being produced by the LSM to produce a visible "spot" on the image which appears on the image at the place on the DUT illuminated by the scanning beam at the time the failure occurred. Because of this "synchronization" between the scanning beam, the DUT image and the ATE failure indication, the ATE-generated "spot" indicates the physical location on the DUT of elements involved in the failure. (paragraph bridging pages 5-6)

According to an aspect of the invention, the ATE can be configured to "short-cycle" the test up to the point of failure detection, when a failure is detected. This effectively improves the test's visual "resolution". "Short-cycling" involves resetting the test back to its starting point whenever a failure is detected. In the present context, a "failure" is a difference between actual responses from the DUT received by the ATE and the predefined expected responses. By resetting the test back to its starting point when a failure is detected, test stimuli (vectors) past the point of failure are not executed, thereby shortening the test cycle and increasing the frequency with which the failure occurs. (page 6, first full paragraph)

Traversing the Rejections

The references relied upon are:
Lo (US 6,462,814), and
Lo et al (US 6,566,897).

Lo (US 6,462,814) discloses beam delivery and imaging for optical probing of a device operating under electrical test. Methods and apparatus for optically probing an electrical device while the device is operating under control of a tester of the kind that applies test vectors and that has a test head in which the device can be mounted. An optical probe system has a light delivery and imaging module that is configured to be docked to a test head and that has imaging optics and a fine scanner. An optical processing subsystem can generate an incoming beam of light to illuminate the device through an optical fiber to a fiber end in the module. The fiber end is mounted in a fixed position on the optical axis of the imaging optics, and the fiber end and imaging optics are mounted in a fixed position to the platform of the fine scanner. Operating the fine scanner moves the fiber end, the imaging optics, the optical axis, and the focal point as a rigid unit. As further described in Lo,

> "In operating the system 10, a user can specify the parameters of a test signal pattern, through the station 20, for example, or through a direct operator interface to the tester. The user can then use the interface station 20 to identify or find a reference node of the DUT at which signal variations are to be detected, for example, by locating a reference

node on a CAD image 36 and comparing the CAD image 36 with an image 34 of the actual circuit layout. Once the reference node has been specified, data processing subsystem 18 sends commands that direct the imaging module 16 to move to the location on the DUT corresponding to the reference node while the tester applies a specified test signal pattern to the DUT. The reflected light from the DUT is transmitted from the imaging module 16 to the probe chassis 72 where it is converted to digital electrical signals that can be processed and analyzed by data processing subsystem 18. The data processing subsystem 18 generates and transmits to the user interface station 20 signals from which an image is produced of the signal variations induced at the reference node as a result of the applied test signal pattern. (column 6, lines 24-43)

More specifically, the system 10 can be used to detect signal variations occurring at an internal node of the DUT. Signal variations in the DUT may be detected by detecting modulation of light reflected from the DUT, as described in commonly-owned U.S. Pat. Nos. 5,872,360 and 5,905,577, which are incorporated herein by reference. In addition, the probe system 70 can also be used as a confocal laser scanning microscope system to take a series of images at many focal planes that intersect the DUT at different depths within the device, and these images may be used to create images of the three-dimensional structure of the DUT." (column 6, lines 44-54)

In essence, Lo (US 6,462,814) simply describes a system whereby a sample under test is put into a microscope and allowed to operate under the power and electronic control of a tester. There is an interface so that a node being tested can be imaged (observed).

Lo et al (US 6,566,897) discloses voltage contrast method and apparatus for semiconductor inspection using low voltage particle beam. Defects in a patterned substrate are detected by inspection with a charged particle beam inspection tool which generates an image of a portion of the patterned substrate and compares the image with a reference in order to identify any defects in the patterned substrate. Parameters of the tool are optimized to improve image uniformity and contrast, particularly voltage contrast. Prior to imaging an area of the substrate, the tool charges an area surrounding the image area to eliminate or reduce the effects caused by asymmetrical charging in the surrounding area. The tool alternates between charging the surrounding area and imaging the image area to produce a plurality of images of the image area, which are then averaged. The result is a highly uniform image with improved contrast for accurate defect detection.

Lo et al (US 6,566,897) is essentially merely an imaging system, and is not geared to exercising a DUT, but rather just imaging it with a low voltage particle beam and comparing the image to a reference image.

Neither of the aforementioned two Lo references describe the control system and feedback which is described (and claimed) in the present patent application.

A feature of the present invention is that the tester and the device under test (DUT) form a closed loop feedback system. This detection system is paramount to detecting real failure signatures as

measured by the tester (in real time) and displayed by the laser scanning microscope (with a signal supplied by the tester). One of the major parts of this closed loop system is the programming of the tester to 'Break' in or out of a vector loop which is detecting pass/fail operation of the DUT. The subsequent synchronization that occurs via laser interaction/tester programming provides optical signatures that only appear on the gate level devices responsible for the failing test.

The prior art patents allude to using reference DUT(s) to compare good versus bad devices. In the present invention, no reference device is required for comparison because only failing signatures are detected in the first place. This is a significant distinction between the prior art and the present invention.

The control system and feedback of the present invention, as well as the tester code required to iteratively 'Break' in or out of either a passing or failing state as measured (in real time and synchronized) by a tester are not described in either of the prior art references. Neither of the prior art references disclose the tester being used as providing real time feedback to the microscope control system and subsequent optical images acquired.

The claims have been amended to emphasize the differences noted above.

Claims 1-20 are canceled.

Claims 21 - 40 are newly-presented.

Newly-presented apparatus **claim 21** is based on canceled claim 20 and canceled claim 10, and some of the features discussed hereinabove.

Newly-presented **claims 22-28** are based on canceled claims 2 and 4-9, respectively.

Newly presented independent method **claim 29** is based on canceled claim 11, and newly-presented claim 21.

Newly presented **claim 30** is based on canceled claim 13.

Newly-presented **claims 31-33** are based on some of the features described hereinabove.

Newly presented **claims 34-40** are based on newly-presented claims 22-28, respectively.

Appl. No. 10/711,556
Amdt. dated 05/24/2005
Reply to Office action of 02/24/05

Conclusion

If there are any further issues to be resolved in this application, the Examiner is requested to contact the undersigned at the number listed below.

Applicant respectfully requests that a timely Noticc of Allowance be issued in this case.

Respectfully submitted,
Howard M. Cohn
Howard M. Cohn
Reg. No. 25,808

Howard M. Cohn
21625 Chagrin Blvd. Suite 220
Cleveland, OH 44122
Voice (216) 752-0955
Fax (216) 752-0957

CERTIFICATE OF TRANSMISSION BY FACSIMILE

I hereby certify that this correspondence is being transmitted to the United States Patent and Trademark Office (Fax No. 703-872-9306) on May 24, 2005.

Name of Person Signing Certificate	: Howard M. Cohn
Signature	: Howard M. Cohn
Datc of Pcrson signing	: May 24, 2005